PHYTOTOXICOLOGY ASSESSMENT SURVEYS IN THE VICINITY OF DOMINION COLOUR CORP. LTD., FINLEY AVE., AJAX OCTOBER 1987 THROUGH JULY 1988

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Phytotoxicology Assessment Surveys In The Vicinity Of Dominion Colour Corp. Ltd., Finley Ave., Ajax - October 1987 Through July 1988.

Background

In October, 1987, staff of the Phytotoxicology Section collected surface soil (0-5 cm) for analysis of chromium and other metals at several locations in the vicinity of the Dominion Colour plant, Ajax. In addition, several moss bag sites were established, with monthly exchanges being made through to July 1988, to assess the status of ongoing, current emissions of metals from this company. The surveys were requested by Mr. G. Mierzynski, Director, MOE Central Region, in view of recent in-plant health related concerns regarding chromium exposure.

Soil samples for chromium (Cr) and lead (Pb) analysis also were collected by staff of the Phytotoxicology Section in the vicinity of Dominion Colour in 1974, 1975 and 1976. These surveys revealed that Cr and Pb levels were elevated in vegetation and/or soil near the company. The highest Cr (93 ppm) and Pb (360 ppm) levels in vegetation (grass) were detected in 1974 and were several times higher than the present respective (5 & 20 ppm) MOE "upper limit of normal" guidelines. Also, Cr but not Pb was found at a few soil sites (55 ppm) to be marginally elevated relative to the present 50 ppm urban Cr guideline.

Recent Sampling Programs

Soil Collection (October 1987)

On October 22, 1987, surface soil (0-5 cm) was collected at several sites in the immediate area of the company as well as at several more remote locations. Duplicate samples were collected at each site with an Oakfield sampler, using standard sampling procedures. A total of 14 sites were sampled, with all but 5 of the soil sites being situated near the company's security fence and on company property. Surface soil (0-5 cm) also was collected in the general area of Sites 1, 2, 3, 4, 5, 8 and 10 in earlier years (1974, 1975, 1976). The location of all soil sampling sites is shown in Figure 1.

Moss Bag Survey (October 1987-July 1988)

Also on October 22, 1987, single moss bags were placed, at a height of about 3 meters, on hydro or telephone poles in the immediate vicinity of Dominion Colour as well as at more remote stations. Thirteen moss bag sites were established in October, with moss Sites 1 & 2 being located on the Dominion Colour property. All other sites were situated off company property and, with the exception of Site 3, were abutting the west side of either Finley Avenue or Mackenzie Avenue. On May 18, 1988, two new moss bag sites (Sites 14 & 15) were established at more remote stations to the east and northeast (see attached Figure 2). The moss bags were replaced at each site on a monthly basis (approximately every 30 days) through to July 18, 1988.

Submission for Chemical Analysis

The soil samples collected in October and the moss bags exchanged at the end of each 30 day exposure period were returned to the Phytotoxicology Section for processing. The soil samples and moss bags were processed on a dry weight basis and were submitted to the MOE Laboratory Services Branch for analysis of chromium (Cr) as well as cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), molybdenum (Mo), nickel (Ni), vanadium (V) and zinc (Zn).

Other Relative Information

The Dominion Colour plant is located in a predominantly industrial/commercial area. The Morton Thiokol Company, situated to the neighbouring west of Dominion Colour, had commenced a building expansion program following the establishment of the moss bag survey. Earth excavated from the Morton Thiokol construction site during late October or early November, 1987 was piled just west of moss Sites 5 and 6 through to the end of the moss bag survey.

A wind recording station is maintained by the MOE in nearby Oshawa and the hourly wind direction data for 1987 and 1988 revealed that winds prevail from the west, northwest, and north.

Analytical Results

Soil Results

In attached Table 1, the soil metal levels detected at each site are compared to the Phytotoxicology Section Upper Limit of Normal (ULN) urban guidelines for surface soil (0-5 cm).

The Phytotoxicology Section Upper Limit of Normal (ULN) guidelines shown in the attached tables represent the expected maximum concentrations of the preceding metals in non-agricultural soil and foliage from urban areas of Ontario not subject to the direct influence of point sources of emissions. The ULN urban guidelines are based upon samples collected from centres of minimum 10,000 population. The ULNs were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. Assuming data are normally distributed, 99% of "urban background" samples will contain concentrations of elements lower than or equal to the ULNs. Thus, exceedances of the ULNs implicate an extraneous pollution source. It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above-normal concentrations. Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations below the guidelines would not normally be considered toxic. A brief review of world literature has shown that the guideline concentrations are generally within the respective ranges of urban background results reported by other investigators.

Table 1 shows that soil levels of Cr (56-140 ppm), Pb (165-430 ppm) and Mo (4-10 ppm) at Sites 1, 2, 12 and 13, all of which were situated on company property to the neighbouring south to east (downwind) of the Dominion Colour plant, were elevated in relation to the levels found at more remote sites. On average, levels of Cr, Pb and Mo at these sites were higher than the corresponding averages for the more remote sites by factors of 2, 8 and 6 times respectively. In the case of Cr and Mo, all levels were found to be at or in excess of the respective (50 and 3 ppm) ULN guidelines. None of the soil Pb levels exceeded the 500 ppm ULN guideline.

Attached Table 2, which compares the 1987 results with those from earlier years, shows that Cr and Pb levels in surface soil (0-5 cm) have increased in the area of downwind Sites 1 and 2 since 1974. The Cr and Pb levels found in 1987 at other comparable sites were not markedly different from the earlier years' (1974, 1975, 1976) results.

The other metal results (Cd, Cu, Fe, Ni, V and Zn) displayed no source related pattern and were all well below the ULN urban guidelines for surface soil.

Moss Results

The monthly moss bag results are summarized in attached Tables 3 and 4. Table 3 shows the range and mean of the metal concentrations found at each moss site during October, 1987 through March, 1988 (5 exposures) and during March, 1988 through July, 1988 (4 exposures). Also shown are the number of occasions (30 day exposures) the metal concentration at each moss site exceeded the urban ULN moss bag guidelines. Urban ULN guidelines for moss have been established by the Phytotoxicology Section for all but two (Mo and V) of the metals. Table 4 shows the exposures and moss sites with metal levels greater than the ULN guidelines.

Chromium, Lead, Molybdenum and Nickel

Moss bag Cr levels in excess of the urban ULN guideline (7 ppm) were detected each month at several sites (Table 4), with the 5 month (October - March) and 4 month (March - July) means for all sites in the immediate area of Dominion Colour being higher than at more remote sites. The highest Cr levels usually were found at downwind Sites 2 and 11, with the highest levels of 43 ppm being found during the 2nd (November - December) and 3rd (December - January) exposures. The highest levels (11 - 25 ppm) found during the other 7 exposures, as well as the highest means (24 ppm) which also were found at Sites 2 and 11 during the October through March period, were higher than the 7 ppm ULN guideline for Cr by upto 2 times.

As with Cr, the highest Pb levels were found during the 2nd (260 ppm) and 3rd (250 ppm) exposures and the highest means (129, 139 ppm) were detected during the October through March period at neighbouring downwind moss Sites 2 and 11. Moss Site 2 was situated on company property just east of the parking lot and it is likely that vehicle emissions contributed to the lead elevation at this site. Although the two highest lead levels were only slightly higher than the urban ULN guideline (200 ppm), and all 5 month (October through March) and 4 month (March through July) means were below this guideline (Table 3), the Pb results in the immediate vicinity of the Dominion Colour plant were, nevertheless, significantly higher than at more remote sites.

The Mo data for each monthly exposure also revealed a pattern of generally higher levels at moss sites in the immediate area of the company compared to more remote sites. The highest Mo levels usually were found at downwind Sites 10, 11 and/or 12 to the east. However, the Mo levels found during the 1st and 2nd exposures (November-December) at Sites 5 (40, 79 ppm) and 6 (220 ppm), just west of Dominion Colour, were the highest to be detected, contributing to Sites 5 and 6 having the highest means (25.4 and 45.3 ppm) for the October through March period (Table 3). The highest levels found during the other 7 exposures (December 1987 through July 1988) generally were lower (6 - 21 ppm), with the highest means for the March through July period being detected at Sites 11 (6.2 ppm) and 12 (4.1 ppm), and being from 4 to 8 times higher than the corresponding means (<0.5 - 0.9) for more remote sites . The Phytotoxicology Section has not developed a ULN guideline for Mo. As the higher levels found at upwind Sites 5 and 6, adjacent to Morton-Thiokol, were markedly elevated relative to all other data, it is possible that the excavation-construction activites at Morton-Thiokol, contributed to the high Mo levels found early in the survey at these moss sites.

In comparing the monthly Ni results to the ULN guideline, only the higher levels detected in April - May (14 - 65 ppm) and in May - June (27 ppm) were found to exceed the 13 ppm ULN guideline (Table 4), which would account for the means for the March through July period being slightly higher than the October through March means (Table 3). The majority of affected sites (Sites 1, 3, 4 , 8, 9, 11 and 12) were situated downwind (south to east) of the Dominion Colour plant. The Ni results for the other 7 exposures were within a normal range (3 - 5 ppm) and displayed no apparent pattern in relation to Dominion Colour.

Cadmium, Copper, Iron, Vanadium and Zinc

The moss bag data shown in Table 3 also revealed a pattern of generally higher levels of Cd, Cu and Zn at one or more sites in the immediate area of the company compared to more remote sites. This pattern was apparent with Cu and Zn during most exposures and with Cd during a few exposures. However, even the highest monthly levels of Cd (2.3 - 3.2 ppm), Cu (23 - 40 ppm) and Zn (130 - 360 ppm) found during the 9 exposures (October 1987 through July 1988) were below the respective (4, 60 and 800 ppm) ULN guidelines. In the case of Fe and V, levels found at neighbouring sites were similar to those found at more remote sites and were below the 3000 ppm Fe guideline. No ULN guideline for V has been developed by the Phytotoxicology Section.

Summary and Conclusions

In light of the results from the soil and moss bag assessment surveys conducted by the Phytotoxicology Section in 1987-88 and from the earlier years'(1974-76) soil collections, the following conclusions can be drawn:

- Soil concentrations of Cr, Pb and Mo in the immediate vicinity of the Dominion Colour plant were found to be well above background levels, with soil Cr and Pb levels having increased at a few sites since 1974. The highest Cr and Mo levels exceeded the ULN urban guidelines, while soil levels of Pb and other metals did not.

- Moss bag concentrations of Cr, Cu, Pb, Mo, and Zn at sites near the company also were generally higher than at more remote sites throughout the entire study period (October, 1987 to July, 1988), while elevations of Cd and Ni were more sporadic. The highest moss bag levels of Cr, Pb and Ni exceeded the respective urban guidelines (no ULN for Mo has been established).

The comparisons of the soil and moss bag results with the ULN guidelines would indicate that Cr, Pb and Mo are the primary elements emitted by the Dominion Colour plant. Elevated levels of these metals in soil were found only on company property, and there has been an increase in soil Cr and Pb levels in the immediate vicinity of the plant over the 13 year sampling interval. Moss bag sites in the vicinity of the Dominion Colour plant also were found to have elevated levels of Cd, Cu, Ni and Zn, suggesting that the company also is an ambient emitter of these metals. However, the fact that no elevation of these metals was detectable at any of the soil sites further suggests that the Dominion Colour plant is a more significant source of Cr, Pb and Mo emissions.

TABLE 1
SOIL METAL CONCENTRATIONS DETECTED IN THE VICINITY OF DOMINION COLOUR AJAX - OCTOBER 1987

Collection Site No.	Approximate Distance and Direction Relative to Centre of Company	[a]Average Soil Concentration (ppm, dry weight basis)								
		Cd	Cr	Cu	Fe	Pb	Mo	Ni	V	Zn
		Sites Closest to Company								
1[b]	80m S	0.4	57	14	12,500	170	4	12	29	75
2[b]	110m SE	0.3	140	13	14,000	430	7	13	28	67
3[b]	80m N	0.3	42	15	17,000	86	3	15	34	55
5	110m W	0.4	36	16	18,500	60	2	17	39	60
10[b]	150m SE	0.4	32	15	17,000	55	2	14	36	60
11	120m SE	0.3	26	13	14,500	34	<1	13	30	57
12[b]	90m E	0.4	56	15	15,000	165	10	14	29	69
13[b]	80m NE	0.3	50	13	15,500	305	8	13	32	57
14[b]	100m NE	0.3	30	13	15,500	49	3	13	32	46
15[b]	90m NW	0.3	34	14	15,000	60	2	15	31	48
16	110m SW	0.4	31	21	17,000	46	<1	16	34	67
		More Remote Sites								
4 [b]	230m N	0.4	25	21	16,000	34	<1	13	32	85
7	290m W	0.3	24	13	15,000	35	<1	12	30	55
8	230m E	0.3	23	12	13,500	22	<1	10	29	46
		Phytotoxicology Section Guidelines								
* Upper Limit of Normal		4	50	100	35,000	500	3	60	70	500

a. Based on duplicate sample results

b. Site on company property

* Phytotoxicology Section Upper Limit of Normal urban guidelines for surface soil (0-5 cm)

Note: Results underlined are equal to or exceeding the urban Upper Limit of Normal guideline

TABLE 2

COMPARISON OF SOIL Cr AND Pb CONCENTRATIONS DETECTED IN THE VICINITY OF DOMINION COLOUR, AJAX DURING 1974, 1975, 1976 AND 1987

Collection Site No.	[a]Average Concentration in 0-5 cm Surface Soil (ppm, dry weight basis)							
	Cr				Pb			
	1974	1975	1976	1987	1974	1975	1976	1987
1 (80m S)[b]	50	38	10	57	50	64	35	170
2 (110m SE)[b]	-	38	55	140	-	77	43	430
3 (80m N)[b]	35	26	23	42	33	86	61	86
4 (230m N)[b]	30	26	23	25	43	34	27	34
5 (110m W)	45	38	30	36	63	71	65	60
8 (230m E)	35	32	23	23	65	35	37	22
10(150m SE)[b]	45	29	29	32	50	155	58	55
* ULN	50				500			

a. Average of triplicate sample results in 1974, 1975 and 1976 and of duplicate results in 1987
b. Site on company property
* Phytotoxicology Section Upper Limit of Normal urban guidelines for surface soil (0-5 cm)

Note: Results underlined are equal to or exceeding the urban guideline

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TABLE 3.

SUMMARY OF ANALYTICAL MOSS BAG RESULTS FOR THE OCTOBER 1987 THROUGH MARCH 1988

FIVE MONTH PERIOD AND FOR THE MARCH THROUGH JULY 1988 FOUR MONTH PERIOD

Sites	Range (R) Mean (M) Exc. (E)	Concentration in Moss (parts per million, dry weight)									
		Cadmium		Chromium		Copper		Iron		Lead	
		Oct. - Mar	Mar. - July	Oct. - Mar	Mar - July	Oct. - Mar	Mar - July	Oct. - Mar	Mar. - July	Oct. - Mar	Mar. - July
		MOSS SITES CLOSEST TO DOMINION COLOUR									
1 [b]	R	<0.3-1.4	<0.3-0.4	6-13	6-13	7-9	8-11	1,100-1,600	1,200-1,700	45-76	37-55
(90m S)	M	0.6	0.4	10	9	8	9	1,240	1,400	56	45
	E[a]	0	0	4	3	0	0	0	0	0	0
2 [b]	R	<0.3-3.2	<0.3-0.5	11-43	8-24	7-12	6-10	1,200-2,000	1,100-1,700	49-260	32-100
(60m S)	M	1.2	0.4	24	17	9	8	1,560	1,325	129	69
	E	0	0	5	4	0	0	0	0	1	0
3	R	<0.3-0.9	0.3-0.4	6-21	4-19	6-7	6-11	950-1,300	970-1,900	37-90	38-66
(120m SE)	M	0.6	0.3	12	13	6	8	1,170	1,268	61	54
	E	0	0	4	3	0	0	0	0	0	0
4	R	<0.3-2.3	0.3-0.9	6-16	5-14	7-11	8-37	970-1,600	1,100-1,800	33-92	26-89
(110m SW)	M	0.9	0.4	11	8	10	17	1,234	1,375	59	55
	E	0	0	3	2	0	0	0	0	0	0
5	R	<0.3-1.5	0.3-0.4	5-20	5-26	6-13	7-14	1,200-2,000	1,100-1,800	37-120	26-98
(110m N)	M	0.8	0.4	12	13	10	11	1,480	1,450	68	59
	E	0	0	4	2	0	0	0	0	0	0
6	R	<0.3-0.9	0.3-0.5	5-11	4-14	7-15	8-14	1,200-2,000	1,500-2,100	37-97	28-120
(150m NW)	M	0.6	0.4	8	9	10	10	1,680	1,775	62	65
	E	0	0	3	2	0	0	0	0	0	0
10	R	0.5-1.5	<0.3-0.7	10-16	4-13	9-23	7-12	1,100-1,900	1,300-1,800	59-86	35-47
(140m NE)	M	0.8	0.4	12	9	14	10	1,360	1,500	67	41
	E	0	0	5	3	0	0	0	0	0	0
11	R	<0.3-0.9	<0.3-0.5	12-43	6-10	6-19	9-24	1,100-2,000	1,100-1,800	68-250	24-59
(140m E)	M	0.6	0.4	24	8	12	15	1,420	1,400	139	47
	E	0	0	5	3	0	0	0	0	1	0
12	R	<0.3-0.7	0.3-0.6	7-13	6-18	11-26	8-40	920-1,600	1,200-1,700	46-72	37-78
(210m SE)	M	0.5	0.4	10	11	18	20	1,205	1,350	64	57
	E	0	0	4	3	0	0	0	0	0	0
MOSS SITES MORE REMOTE											
7	R	<0.3-0.6	0.4-0.7	4-6	4-9	8-10	8-9	1,400-1,800	1,500-1,800	35-51	34-46
(230m NW)	M	0.5	0.5	5	7	9	9	1,600	1,675	41	42
	E	0	0	0	2	0	0	0	0	0	0
8	R	<0.3-0.8	<0.3-0.4	5-8	5-9	6-12	8-13	1,100-1,800	1,400-1,500	28-41	26-37
(250m S)	M	0.6	0.3	6	7	8	10	1,360	1,425	35	32
	E	0	0	1	1	0	0	0	0	0	0
9	R	<0.3-0.9	<0.3-0.3	5-9	6-8	7-17	11-29	1,200-2,000	1,200-1,800	33-120	28-45
(250m N)	M	0.6	0.3	6	7	11	16	1,460	1,500	54	34
	E	0	0	2	2	0	0	0	0	0	0
13	R	<0.3-0.9	0.3-0.4	4-8	3-10	7-8	7-9	980-1,900	1,000-1,800	31-58	[illegible]
(390m SE)	M	0.5	0.4	6	6	8	8	1,316	1,250	40	[illegible]
	E	0	0	1	1	0	0	0	0	0	0
14	R	-	<0.3	-	3	-	7	-	1,000	-	32
(420m E)	M	-	<0.3	-	3	-	7	-	1,000	-	32
	E	-	0	-	0	-	0	-	0	-	0
18	R	-	0.3-0.5	-	4-8	-	6-11	-	1,100-1,300	-	30-51
(430m NE)	M	-	0.4	-	4	-	8	-	1,190	-	42
	E	-	0	-	0	-	0	-	0	-	0

PHYTOTOXICOLOGY SECTION URBAN GUIDELINES

	Cadmium	Chromium	Copper	Iron	Lead
UPPER LIMITS OF OF NORMAL	4	7	40	3,000	100

[a] Number of exceedences of Upper Limit of Normal urban guideline

[b] - Site on company property

* Approximate distance and direction relative to centre of company

TABLE 3 (Cont'd)

SUMMARY OF ANALYTICAL MOSS BAG RESULTS FOR THE OCTOBER 1987 THROUGH MARCH 1988 FIVE MONTH PERIOD AND FOR THE MARCH THROUGH JULY 1988 FOUR MONTH PERIOD

Sites	Range (R) Mean (M) Exc. (E)	Concentration in Moss (parts per million, dry weight)							
		Molybdenum		Nickel		Vanadium		Zinc	
		Oct. - Mar.	Mar. - Jul.	Oct. -Mar.	Mar. - July	Oct. -Mar.	Mar. - July	Oct. - Mar.	Mar. - July
		MOSS SITES CLOSEST TO DOMINION COLOUR							
1[b]	R	0.8-3.0	0.8-1.3	3-4	4-14	5-6	5-7	56-72	54-65
(90m S)	M	1.4	1.0	3	7	6	6	65	58
	E[a]	-	-	0	1	-	-	0	0
2[b]	R	1.4-54	0.9-1.8	3-5	4-10	5-8	5-7	86-210	54-97
(60m S)	M	12	1.5	4	6	6	6	131	82
	E	-	-	0	0	-	-	0	0
3	R	1.0-4.9	<0.5-2.2	3-4	3-14	5-7	4-7	65-150	50-100
(120m SE)	M	3.0	1.4	3	7	6	6	87	69
	E	-	-	0	1	-	-	0	0
4	R	1.1-29	<0.5-2.2	3-4	3-65	4-5	5-7	110-260	53-180
(110m SW)	M	7.0	1.0	3	20	5	6	176	123
	E	-	-	0	1	-	-	0	0
5	R	0.8-79	0.5-3.0	3-5	4-6	5-8	5-7	79-120	48-140
(110m W)	M	25.4	1.4	4	5	6	6	96	97
	E	-	-	0	0	-	-	0	0
6	R	0.9-220	<0.5-4.4	3-5	4-9	5-7	5-7	93-170	59-230
(150m NW)	M	45.3	1.8	4	6	6	6	143	132
	E	-	-	0	0	-	-	0	0
10	R	2-26	1.3-6.9	3-5	4-6	5-8	5-8	74-170	63-97
(140m NE)	M	11.8	2.8	4	6	6	6	117	77
	E	-	-	0	0	-	-	0	0
11	R	2.7-72	0.7-21	3-5	3-15	6-7	5-7	110-150	61-150
(140m E)	M	21.3	6.2	4	7	6	6	134	94
	E	-	-	0	1	-	-	0	0
12	R	1.9-7.1	1.0-8.7	3-4	4-23	5-6	5-7	93-360	61-300
(210m SE)	M	6.6	4.1	3	9	6	6	173	146
	E	-	-	0	1	-	-	0	0
		MOSS SITES MORE REMOTE							
7	R	<0.5-40	0.6-1 2	3-5	4-6	6-7	5-7	67-87	55-160
(230m NW)	M	1.6	0.8	4	6	6	6	77	104
	E	-	-	0	0	-	-	0	2
8	R	<0.5-8.6	0.6-1.1	3-5	4-15	4-7	5-7	60-91	51-67
(250m S)	M	2.2	0.8	4	7	5	6	75	57
	E	-	-	0	1	-	-	0	0
9	R	1.1-4 5	0 8-1.2	3-5	3-27	5-8	5-8	62-95	54-89
(250m N)	M	2 7	0.9	4	10	6	6	80	73
	E	-	-	0	1	-	-	0	0
13	R	<0.5-7.1	<0.5-1.0	3-5	3-7	5-7	5-7	56-79	41-65
(390m SE)	M	2.3	0.7	4	5	6	6	66	58
	E	-	-	0	0	-	-	0	0
14	R	-	<0 5	-	3	-	5	-	77
(420m E)	M	-	<0.5	-	3	-	5	-	77
	E	-	-	-	0	-	-	-	0
15	R	-	<0.5-<0.5	-	4-4	-	5-5	-	51-98
(430m NE)	M	-	<0.5	-	4	-	5	-	75
	E	-	-	-	0	-	-	-	0

PHYTOTOXICOLOGY SECTION URBAN GUIDELINES

UPPER LIMITS OF NORMAL	-	13	-	800

[a] Number of exceedences of Upper Limit of Normal urban guideline

[b] - Site on company property.

* Approximate distance and direction relative to centre of company.

TABLE 4

EXPOSURES DURING WHICH MOSS SITES WERE FOUND TO HAVE METAL CONCENTRATIONS IN EXCESS OF THE RESPECTIVE URBAN GUIDELINES

Exposure Period	Sites Where Exceedances Were Found						
	Cd	Cr	Cu	Fe	Pb	Ni	Zn
Oct. - Nov.	-	2,5,10,11,12	-	-	-	-	-
Nov. - Dec.	-	1,2,3,4,5,6, 8,9,10,11,13	-	-	2	-	-
Dec. - Jan.	-	1,2,3,4,5,6, 9,10,11,12	-	-	11	-	-
Jan. - Feb.	-	1,2,3,10,11,12	-	-	-	-	-
Feb. - Mar.	-	1,2,3,4,5,6,10 11,12	-	-	-	-	-
Mar. - Apr.	-	1,2,3,4,5,6,7, 10,11,12	-	-	-	-	-
Apr. - May	-	1,2,3,4,5,6,7,8, 9,10,11,12,13	-	-	-	1,3,4,8, 11,12	-
May - June	-	1,2,3,9,10,12	-	-	-	9	-
June - July	-	2,11	-	-	-	-	-
ULN*	4	7	60	3,000	200	13	800

* Phytotoxicology Section Upper Limit of Normal urban guidelines for moss

Figure 1: Soil Collection Sites (●) - October 1987

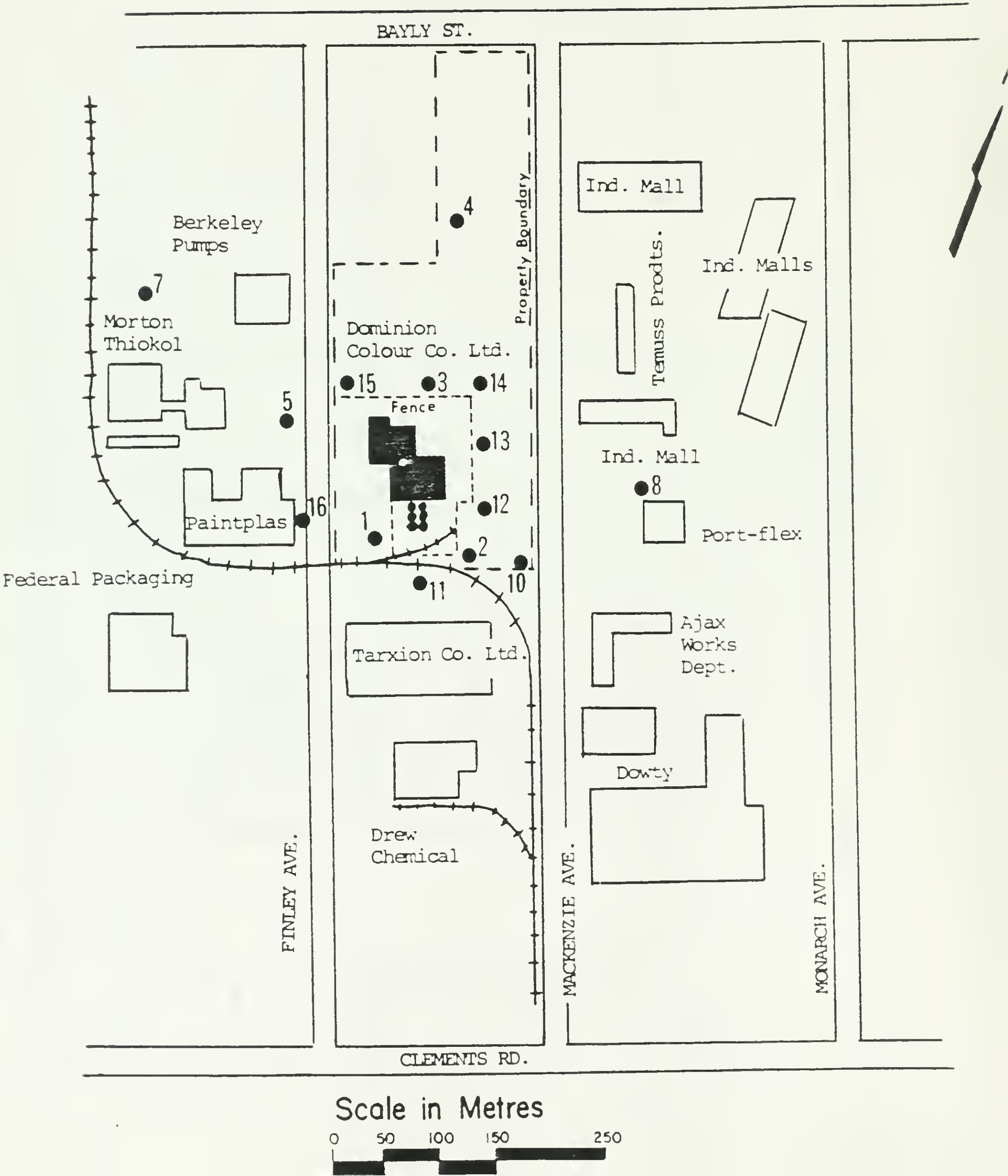

Figure 2: Moss Bag Sites (■) - October 1987 - July 1988